SDO Update

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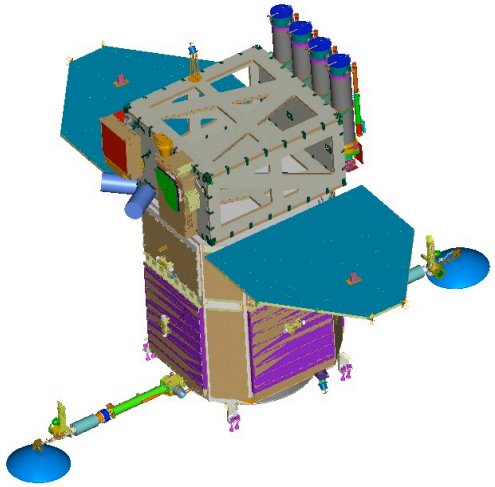
Outline

- Introduction
- Spacecraft
- Instruments
- Schedule
- Data Comments
- Budget Notes
- What's Left

Solar Dynamics Observatory

The First Space Weather Research Network Mission in NASA's Living With A Star Program



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- August 2008 launch
- Inclined Geosynchronous Orbit
- Dedicated ground station
- Continuous 150 Mbps Ka-Band downlink
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- Flight hardware is being built
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Key Technologies
- Ethernet Chipset
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- Active Pixel Star Tracker

Mission Science Objectives

SDO's goal is to understand, driving towards a predictive capability, the solar variations that influence life on Earth and humanity's technological systems by determining

•*How the Sun's magnetic field is generated and structured*

•*How this stored magnetic energy is converted and released into the heliosphere and geospace in the form of solar wind, energetic particles, and variations in the solar irradiance.*

Science Investigations

Helioseismic and Magnetic Imager (HMI)

PI: Phil Scherrer, Stanford University

Images the Sun's helioseismic, longitudinal and vector magnetic fields to understand the Sun's interior and magnetic activity

EUV Variability Experiment (EVE)

PI: Tom Woods, University of Colorado

Measures the solar extreme ultraviolet (EUV) spectral irradiance to understand variations on the timescales which influence Earth's climate and near-Earth space

Atmospheric Imaging Assembly (AIA)

PI: Alan Title, Lockheed Martin Solar Astrophysics Laboratory

Images the solar atmosphere in multiple wavelengths to link changes to surface & interior changes

SDO Instruments

- HMI: Helioseismic Magnetic Imager, combines rotating polarizers with Michelson Interferometers to measure the intensity of the Fe I 6173 line at several wavelengths and polarization states. Produces Dopplergrams and Vector Magnetograms.
- EVE: Extreme ultraviolet Variability Experiment, measures the solar EUV spectral irradiance between 0.1 and 122 nm. MEGS-A is a glancing-incidence spectrograph, MEGS-B is a double-bounce spectrograph, ESP uses radiometers. Produces EUV spectral irradiances.
- AIA: Atmospheric Imaging Assembly, four telescopes that image the Sun in 10 bandpasses. Transmission filters and mirror coatings are combined to produce narrow-band filters. Produces radiance images that can be combined to form temperature maps of the lower corona.

Spacecraft

- SDO is building flight hardware.
- Every subsystem is also building the test units that are used to verify the design and workmanship.
- The harness (several hundred kgs of cables) is being fitted onto a test structure.
- The Mission Operations Center (MOC) has been constructed. It will be used during integration and testing.
- Ground system has some components in place (the DDS) but the 18-m antennae are not yet complete.

Spacecraft

Above: The Instrument Module before being tested at GSFC.

Left: The Structural Verification Unit in the Static Test Facility. It gets pulled and poked to verify that the spacecraft can survive launch and how it rings.

HMI Optics Package

Internal Harness
(Removed for pot test)

BDS Fold Mirror
(In place, bond after oven Alignment is complete)

BDS Beamsplitter
(In place, bond after oven Alignment is complete)

CCD Fold Mirror
(Bonding completed)

Detector Assembly
(Board assembly complete
Side hb test complete
Front hb test in progress)

Flex-Cables
(Flight in house)

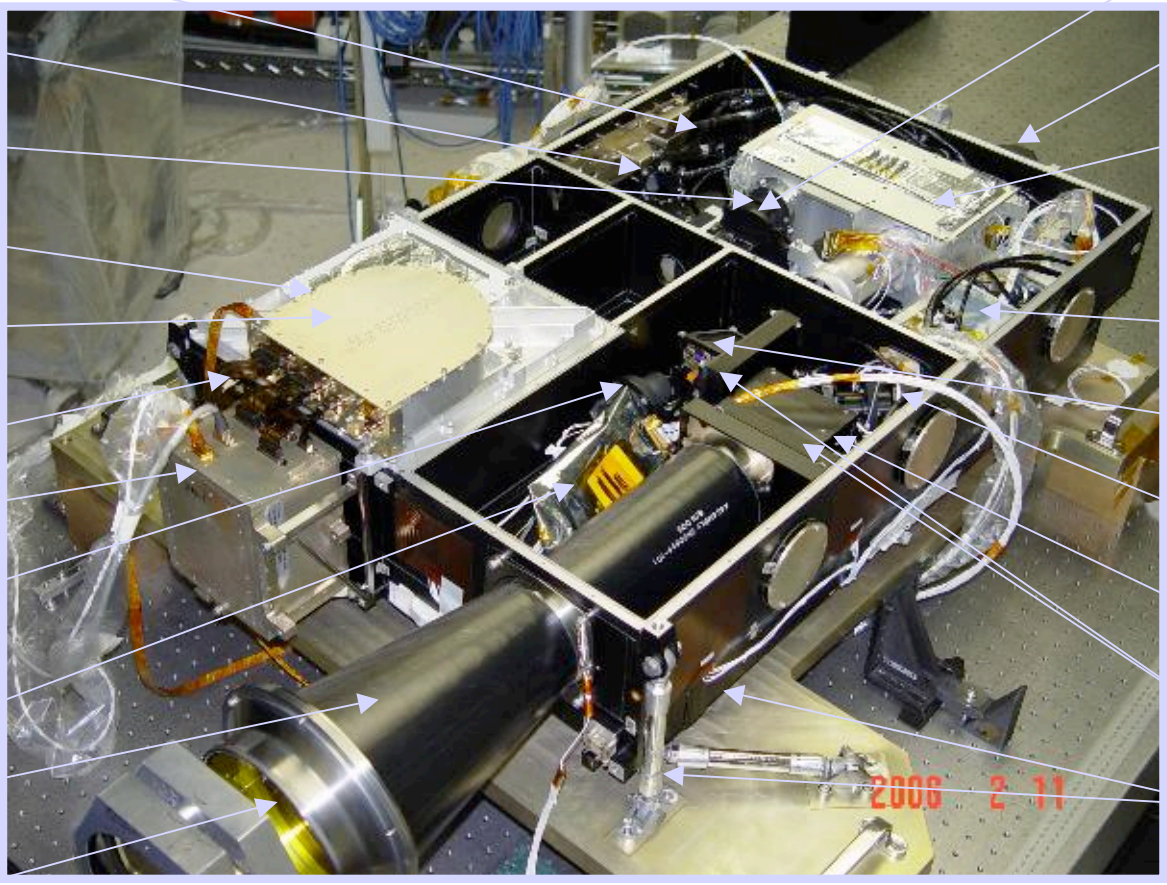
CEB
(DM1 in use for CIF testing)

Limb Sensor
(finish after telescope is reinstalled)

Limb Pre-amp Box
(Waiting for Sun to select Lab set resistors)

Telescope
(Bonding completed)

Front Window
(Flight, needs heaters installed)



Shutters
(Done)

Alignment Mechanism
(Done)

Oven Assembly
(see sheet 4)

Oven Controller
(Bake-out completed)

ISS Beam Splitter
(Ready for bonding)

ISS Mirror
(Bonding completed)

Polarization Selector
(Bonding in work)

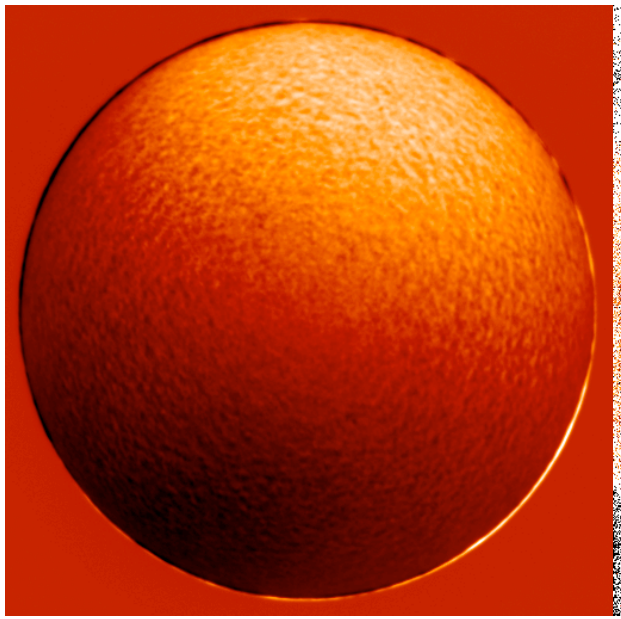
Focus/Cal Wheels
(Bonding completed)

Structure
W/ legs and heaters
(Done)

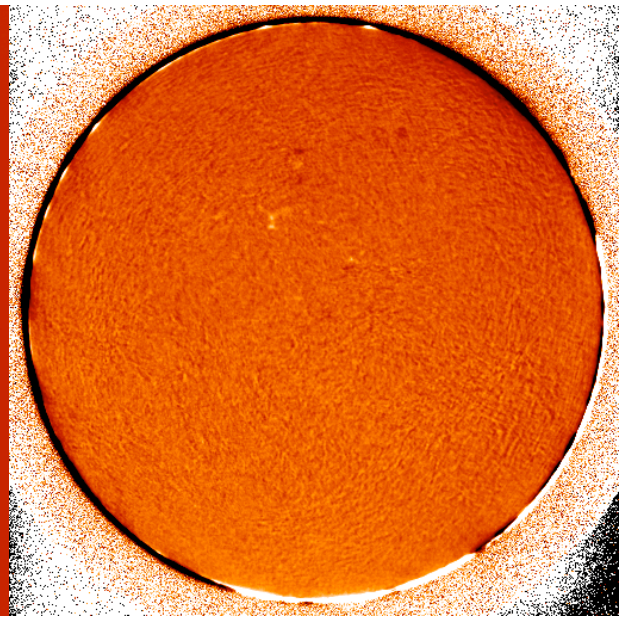
Optics Package Assembly

Calibration summer 2006

HMI Testing



Dopplergram

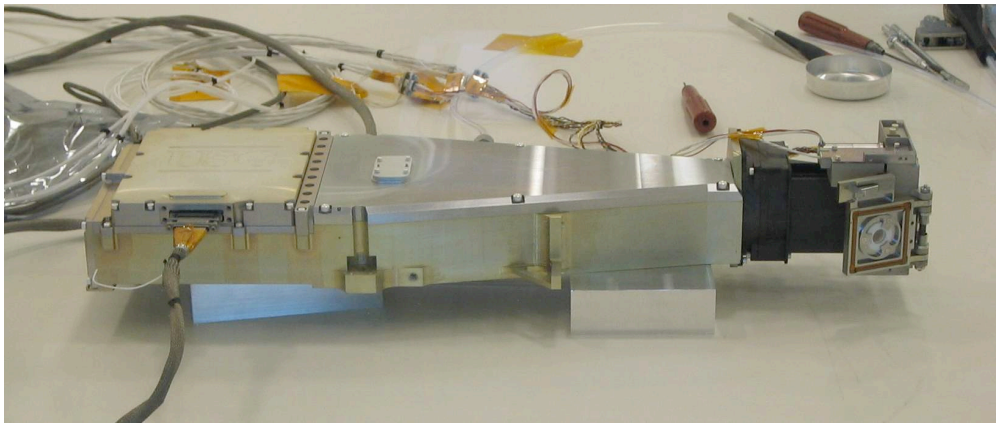


Magnetogram

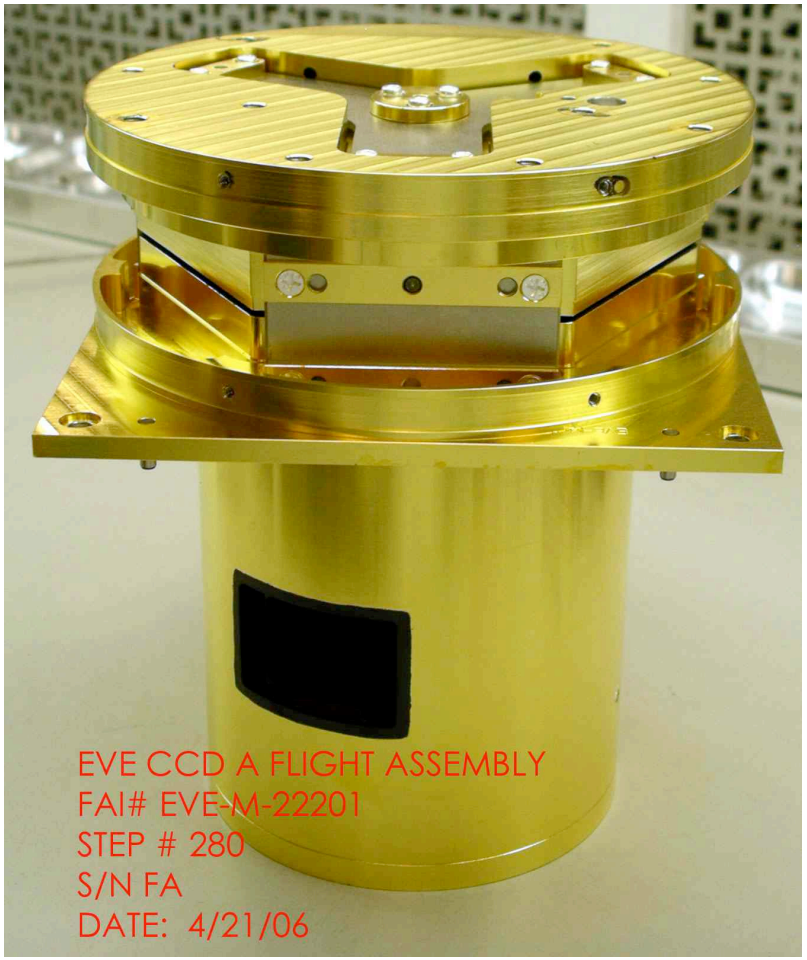
Michelsons, the heart of HMI

Testing of HMI has produced preliminary data, but the real test will be this summer.

EVE Flight Hardware



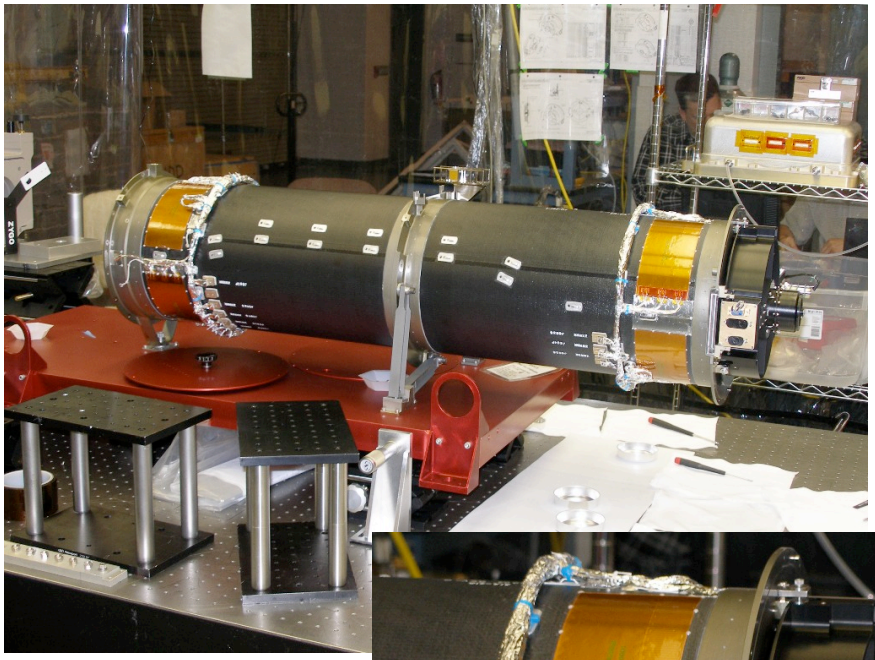
ESP (Extreme Ultraviolet Photometer) ready for calibration at NIST.



MEGS A CCD Holder

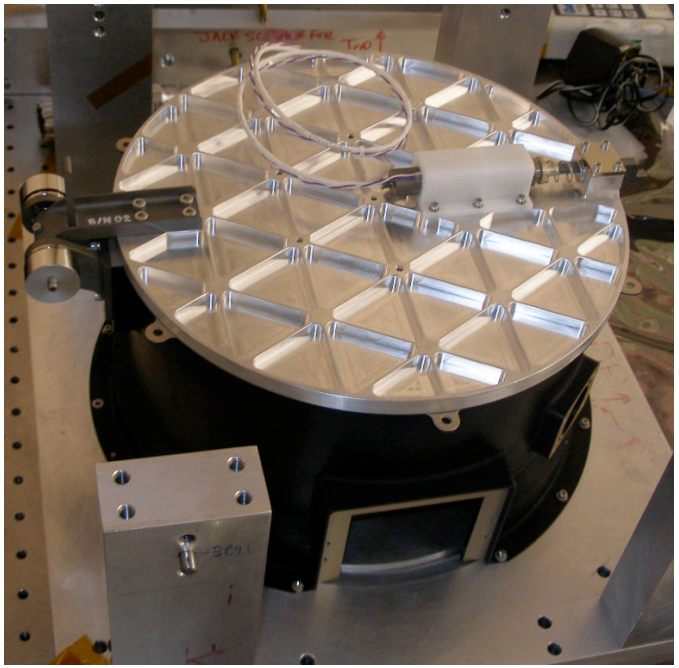
The EVE team is building their instruments and test units. They will be calibrated at SURF in Gaithersburg, MD. ESP was at SURF in March.

AIA Flight Telescopes

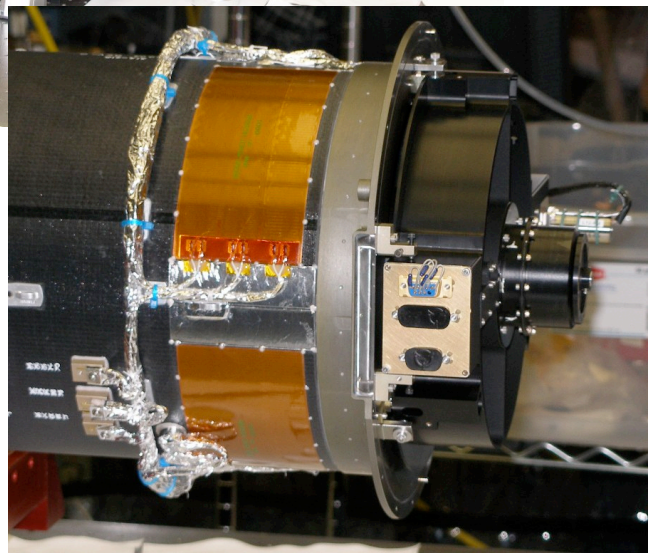


Telescope #2, Fe XIV 211 & Fe XII/XIV 193, under construction, others will follow.

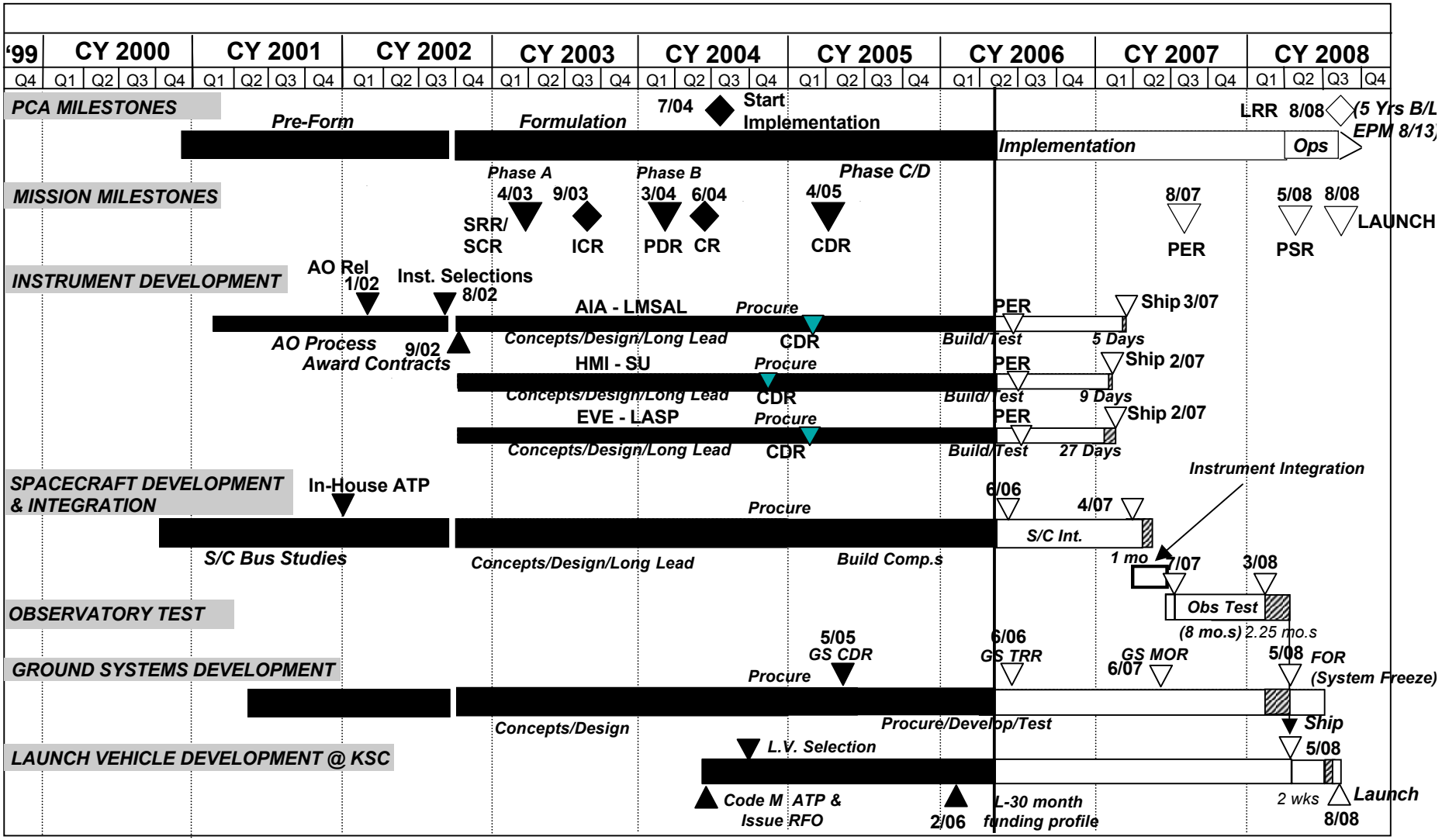
Detail of front door



Detail of spider



SDO Summary Schedule



As of: May, 2006

Legend: Original Date | Original Date | Progress Bar | Schedule Reserve (S/C 3.25 months, GS 2 months)

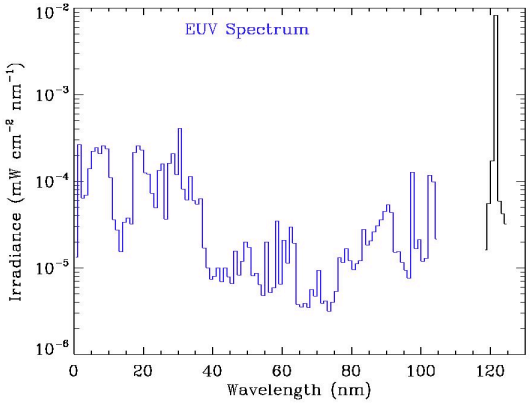
SU=Stanford University LMSAL= Lockheed Martin Solar Astrophysics Laboratory LASP= Laboratory For Atmospheric and Space Physics

What Do We Get?

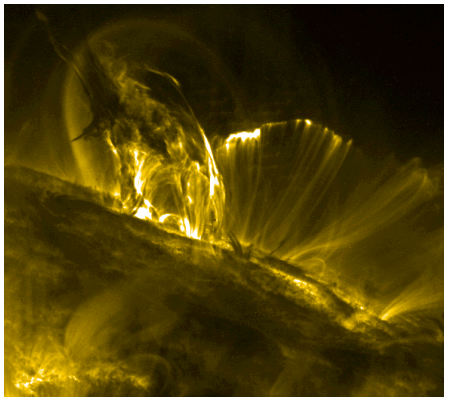
- Science studies of the Sun
  - Internal structure
  - Convection modeling
  - Magnetic dynamo
- Synergistic data for Living With a Star research
  - solar inputs to the heliosphere and ionosphere (Sentinels and ITSP)
  - Space Weather information
  - Predictions of solar activity at Earth, Moon, and other planets
- Data for other researchers

Data Products

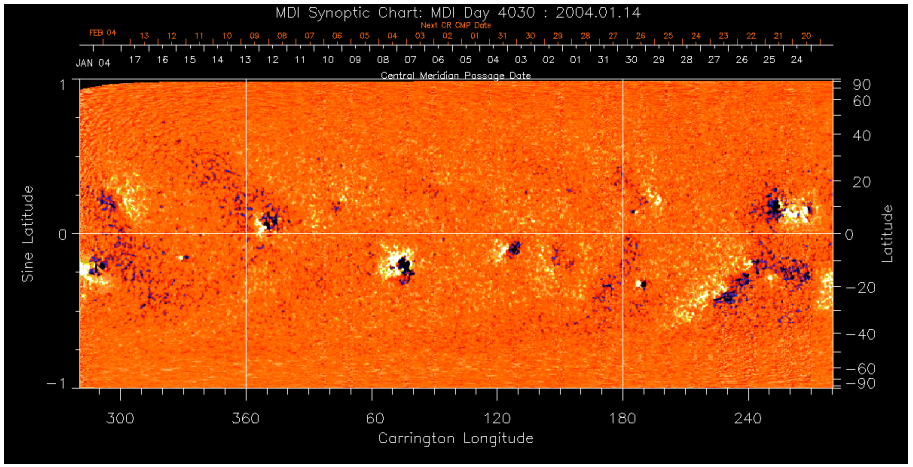
The SDO instruments will produce a set of basic data at a rapid cadence that are sent to the ground for analysis. There are few observing modes. You observe in the data base.



EUV Spectral Irradiance (10 sec)



EUV/UV Images (8 sec)



Longitudinal Magnetograms (50 sec; Vector 10 min.)

Dopplergrams (50 sec)

Data Access

- The science teams on SDO are committed to the open data policy espoused by LWS
- Their previous data sets supported by NASA, such as SOHO/MDI, Trace, and TIMED/SEE, have been freely available
- Some of the pipeline software is based on the previous missions but requires adaptation to the new file systems, size of data sets, and cadence
- Data is served by the Science Operations Centers, located at each Science Team's institution
  - HMI/AIA use a JSOC, with data at Stanford and T&C at LMSAL

SOC Development Status

- The EVE SOC and the AIA/HMI JSOC have been approved and both are being built
- Command & telemetry through the MOC is another part of the SOC is also in the implementation phase
- Prototypes of JSOC hardware are being exercised
- High-Speed Bus (HSB) was tested using EVE data and flowing data to LASP, other tests are planned
- The planned processing pipelines will be built and running prior to launch. We plan a 72-day, end-to-end test of most components 6 months before launch (1st Q 2008 with the current launch date of August 2008.)

Science Working Group

Each Science Team has had a meeting. Various working groups are starting to interact, setting up the higher-level analyses.

The SDO Science Working Group will meet next in Boulder just before the LWS 1 Workshop in March 2007.

Instrument book containing descriptions of the instruments and their calibration is planned for soon after launch. That will be followed by a first results book 18-24 months after launch.

E/PO

SDO is developing a robust E/PO program. Emilie Drobnes, our E/PO lead, has been working with museums, schools, and the Science Teams to keep SDO and solar science in the public eye. We are currently emphasizing engineering opportunities at NASA, will change to a solar science emphasis after SDO is launched.

Web site is being reworked, with an E/PO site in place.

SDO - E/PO at a Glance…

Inspiring the next generation….as only NASA can.

- **Planet Walk** - Friends of AA County Trails
  - Sun Station Dedication Ceremony
  - Pluto panels (APL) & Re-designed Sun Panels 200
- **Chesapeake Children's Museum**
  - Sun Earth Days – 2003-2006
  - Brownie Troops - NASA Career Day
  - Kids-n-Kaboodle – Return to Flight, Living/Working in Space
  - Everything Under The Sun – exhibit
- **Classroom Visits and Internships**
  - 4 Internships
  - In-School Field Trips
- **NASA Explorer Schools Workshop**
  - Middle school science teachers

Budgets

SDO is a cost-capped mission. This includes

Building the spacecraft, instruments, and ground system;

Running the spacecraft and ground system at GSFC;

Running the instruments at the SOCs;

Accepting, analyzing and serving the science by the SOCs.

What's Left?

A satellite is designed and built over a number of years. The SDO Science Definition Team report was released in October 2001 and the AO for SDO in early 2002. Since the instruments were selected the science we can do with SDO data has increased. Models of the solar convection zone have improved; our understanding of the response of the Earth's ionosphere to the Sun has benefited from the SEE data; quantitative interpretations of solar EUV images have begun to appear.

SDO Science Teams could not anticipate what would happen since they designed their investigations.

Further R&A support is required to analyze the SDO data and obtain the full scientific return of the mission.

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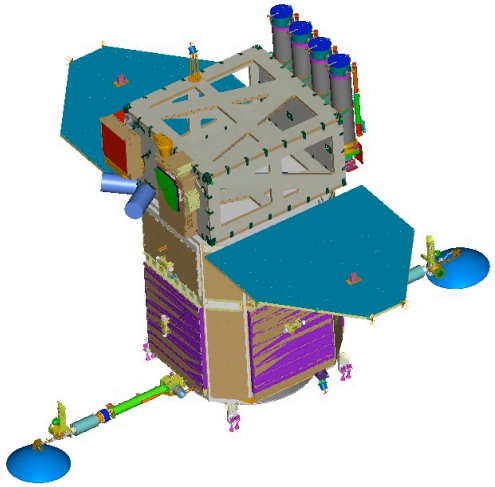

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